ENGINEERING MAINTENANCE BRANCH BULLETIN

Issue # 014

THIS ISSUE CONTAINS:

This is *the* engineering maintenance management bulletin to MSC ships and shoreside personnel. The purpose of the bulletin is to inform all concerned of current COMSC Preventive Maintenance management practices associated with any new or revised policy and procedures, along with helpful tips & tricks for improved maintenance. The bulletin will also discuss and present any upcoming initiatives in the various programs.

We continue our efforts to bring you useful information with the page dedicated to the Vibration Monitoring System (VMS). This will have useful tips as well as past case histories.

PICTURE OF THE MONTH REQUEST - WE NEED *YOUR* PICTURES!!

It is said, **"A picture's worth a thousand words!"** If you have pictures of Shipboard Maintenance (Vibration Monitoring, Oil Sampling, machinery upkeep, etc.) being performed, or a visit from a SAMM or VMS Tech Rep, please send them (along with a *brief* narrative as to what the picture is about) to Norman Wolf (e-mail: norman.wolf@navy.mil).

Aboard the USNS LEWIS & CLARK (T-AKE 1), DLI Engineering's Mike Johnson takes initial vibration data (using a DCA-31 data collector) on one of the Main Machinery Room exhaust fans during the Machinery Vibration Baseline Survey performed underway. "First-of-the-Class" surveys provide a wealth of knowledge for enhancing the performance monitoring of this and follow-on vessels' machinery.

SAMM/Maintenance Tips

Extend the life of your LogBook PDA battery: For units with conventional disposable batteries, leave unit out of the cradle. This will prolong the life of the batteries in the unit.

-Reader Tips provided by Seaworthy Systems Incorporated (SSI)

Human Error Tip. To minimize human error, the culture should:

a. Allow the boss to hear bad news.
b. Identify and address potential failures proactively before they materialize.
c. Realize that punishing people does not necessarily eliminate the risk of recurrence of the same failure somewhere else.
d. Not blame the regulator for failing to monitor closely enough.
e. Make the concept of Root Cause Analysis an integral part of the organizational culture.

-Tip provided by Reliability Center Inc., http://www.reliability.com

Electric Motor Maintenance Program Review

(By David M. Greer, Elec. Engineer, N711)

According to two separate studies performed in the past three years, electrical maintenance on the T-AOE-6 and T-AKR-300 class vessels accounts for one-third of all shipboard maintenance. Motor maintenance alone accounts for 1/3 to 1/2 of an electrician's work time on T-AOE-6 and T-AKR-300 class vessels. These numbers can be expected to be similar for other MSC vessels. The electrical portion of shipboard maintenance, specifically electric motor maintenance, is critical and deserves a significant amount of attention.

Our objective is to provide tools which will establish an effective motor maintenance program to prevent unexpected failures through planned motor maintenance efforts. Recent research performed on electrical technologies currently on the market has revealed an array of motor diagnostic tools. Only a few of these technologies are currently being employed by MSC as a part of our electrical *Condition-Based Maintenance* (CBM) program. These are infrared thermographic inspection and insulation resistance testing by means of megger devices, and/or insulation resistance constant monitoring devices (e.g. MSE's FailSafe Insulation monitors used on several MSC vessels).

Infrared thermographic inspection, an online (i.e. system needs to be energized while testing) preventative maintenance technique using an infrared camera, is useful in detecting loose connections, overloaded circuits, and poorly maintained electrical equipment due to abnormal increases in heat. The faults that are detected are trended based upon degree of fault.

Insulation resistance testing, an offline (i.e. system is de-energized) preventative maintenance technique, places a DC voltage between the motor windings and ground. The megger device and insulation resistance monitor device detect current leakage and then convert to meg-, gig-, or tera-Ohms. Thus, this form of testing provides early warning of insulation degradation and breakdown helping to reduce motor start-up failures.

In addition to Thermography and insulation resistance testing, there are plenty of other motor diagnostic techniques. In Dr. Howard Penrose's article, *Multi-Technology Approach To Motor Diagnostics* (see http://www.iemd.org/toc.htm), he describes methods such as high potential (HiPot) testing, surge testing, polarization index (PI) testing, ohm meter testing, vibration analysis, ultrasonic testing, voltage/current testing, Motor Circuit Analysis (MCA) testing, and electrical signature analysis (ESA) also known as Motor Circuit Signature Analysis (MCSA). Here is a brief description of each:

- *High potential* testing evaluates the insulation between the motor windings and ground by applying a voltage twice the value of the motor rated voltage plus 1,000V for AC and an additional 1.7 times that value for DC high potential. This test is considered ***potentially destructive*** as opposed to insulation resistance testing.
- *Surge comparison* testing is a go/no-go test that compares the impedance of each motor phase graphically by using pulses of voltage at values calculated the same as high potential testing. This test detects shorted turns within the first few turns of each phase and is considered ***potentially destructive***.
- *Polarization Index* testing is used to detect severe winding contamination or overheated insulation systems. An insulation tester is used and the 10 minute to 1 minute values are viewed and a ratio is produced.
- *Ohmmeter* testing detects loose connections, broken connections, and very late stage winding faults by measuring and comparing ohmmeter values between windings of an electric motor.
- *Vibration analysis* measures mechanical vibration using a transducer, which provides tri-axial vibration values and performs Fast Fourier Transform (FFT) analysis. These values are indicators as to the condition of numerous mechanical components, such as bearings and alignment. Rotor faults can be detected as long

as the electric motor meets the minimum load requirement.

- *Ultrasonic* testing measures low and high frequency noise to detect variety of electrical and mechanical faults towards the late stages of their development.
- *Electrical Signature Analysis (ESA)* testing is an online technique, which uses the electric motor as a transducer to detect electrical and mechanical faults. ESA detects early rotor faults, late-stage stator faults and mechanical problems in their later stages. ESA is usually used as a go/no go test but it does have trending capabilities.
- *Motor Circuit Analysis (MCA)* testing is a non-destructive offline technique, which uses a low voltage output while taking and evaluating trendable readings through a series of bridges. MCA devices use a combination of values for resistance, impedance, inductance, capacitance, phase angle, current frequency response and insulation testing to troubleshoot and evaluate control, connection, cable, stator, rotor, air gap and insulation to ground health.

Several common approaches to the incorporation of multiple technologies already exist in the electrical maintenance industry. In general, a combination of offline and online testing to join both electrical and mechanical disciplines is recommended since both types of tests identify faults that the other type cannot. For example, insulation problems can only be detected by using an offline/de-energized test, whereas online testing is necessary to detect issues with vibration, alignment, load, bearings, and power quality.

Dr. Penrose further points out in his article that in a 2003 *Motor Diagnostic and Motor Health Study*, *"38% of motor system testing involving only vibration and/or infrared saw a significant return on investment. This number jumped to 100% in systems that used a combination of MCA/ESA along with vibration and/or infrared."* Vibration and Infrared Thermography, our current technologies, are capable of early detection of faults with cables, stators, rotors, or air gaps. Combining MCA testing with MSC's vibration analysis and infrared thermography programs would provide the early detection of faults from power quality, controls, connections, bearings, insulation, vibration, alignment, and load. Thus, MSC's fleet (in particular, vessels driven by electrical propulsion) would notice a significant increase in early warning detection of potential motor faults, which can facilitate advance planning prior to the need for a repair.

It should be noted that although MCA instrumentation has not yet been tested on MSC vessels for actual diagnostic results, several manufacturers of this technology will soon be demonstrating the functionality and capabilities of their devices so that we can determine the true benefit of including it in the MSC maintenance program. N7 also plans to make site visits to referenced companies who are using this technology in order to determine what benefits they are receiving and to allow MSC fleet representatives to discuss the technologies with the company's electricians. Once the demonstrations have been made and if the MCA devices prove to be useful and user-friendly to the shipboard engineer, N7 will research how best to implement this as planned maintenance in SAMM. From there, N7 will provide vessel class managers with test results along with recommendations for using the instrument and N7's proposed new planned maintenance, affected equipment, and PM periodicity in SAMM.

For additional information or if you have any questions, contact David Greer (david.greer1@navy.mil).

Engineering Maintenance Branch Website

http://www.msc.navy.mil/n7/engmgmt/engmgmt.htm

Check out the Engineering Maintenance Branch web page. It has some helpful downloads (SAMM, PENG, EASy overviews, OAS Guide, *past issues of the bulletin*, etc.), the latest CMEO Class information and who to contact for questions or comments regarding Engineering Maintenance. Stop by now!

COMING UP FOR *NEXT ISSUE*:

More SAMM/Maintenance Tips!!

Vibration Monitoring & Performance Statistics

Another 'Question of the Month!'

A New Picture of the Month!

Vibration Monitoring Tips & Information

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Question of the Month: Man-hour Estimates in SAMM?

(By David Greer, N711e)

Why don't the man-hour estimates in SAMM PM reflect the 'actual' time it takes to complete a maintenance action?

The man-hour estimates are intended *only to provide a guide* for performing the planned maintenance for one unit. The criteria for assigning man-hour estimates is the time it would take an experienced technician, at the jobsite, with all necessary tools, parts, etc. to complete the job. Time is not taken into account for set up, clean up or any follow on corrective maintenance if required based on the PM. Each class of ships is configured differently. The location of the machine shop on one ship may not be the same location as on another ship. Therefore, the 'actual' man-hour time for the same PM on various vessels may take different times to complete since the tools, cleanup materials, etc. are not in the same locations.

For additional information or any questions, please contact David Greer (Ph: 202-685-5738, e-mail: david.greer1@navy.mil).

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CMEO Training – What Are YOU Waiting For????

CMEO (**C**IVILIAN **M**ARINE **E**NGINEERING **O**FFICER) is a two-week training course (held *quarterly*) at the Naval Supply Corps School in Athens, GA. It is for both shipboard and shoreside engineers. The Engineering Directorate of Military Sealift Command hosts the course and encourages ***ALL*** MSC Engineers (3rd A/Es through Chief Engineers, as well as Port Engineers and Project Engineers) to attend *(**Note:** MSC shipboard engineers are given priority when classes are full).*

CMEO provides training on an array of topics such as: SAMM (Condition Monitoring, Maintenance Scheduling and Repair, Diesel Engine Analysis, Logbook, etc.), Vibration Monitoring, Lube Oil, Fuel Oil (NEURS), Chemicals (boiler treatment, sewage treatment, etc.), Supply (COSAL, ShipCLIP), Environmental, and Safety. SAMM is interactively taught using actual data and each module is discussed extensively.

LAST CY '06 class!

- December 04-15, 2006 ← **Apply for NOW!**

For further information and to sign up, please go to the CMEO website: http://63.219.124.12/cmeoclasssignup/cmeo.htm, or contact Dave Greer (david.greer1@navy.mil) with any questions.

FEEDBACK – IT'S A "BRIGHT" IDEA

With each issue, we get more and more requests for the newsletters, from both shoreside *AND* shipboard engineers, so we know you're reading them. **Take the time and tell us what YOU think and what YOU want to see on these pages!** Feedback is **essential** in making this bulletin a help to do your job "smarter not harder" for all shipboard personnel. Please pass on **any** feedback from your Engine Department personnel. We'll post more feedback in future issues in a new column.

Make this ***YOUR*** Maintenance Management Bulletin. If there's a SAMM or Maintenance tip, topic, question, suggestion, or comment on an article, or something relating to Engineering Maintenance you think should get out to the ships, please pass it on. Send your submission to Randy Torfin (randel.torfin@navy.mil) *OR* Norman Wolf (norman.wolf@navy.mil).

How Bad Is That Machine Problem and How Soon Does It Need To Be Fixed?

(By Bill Watts, DLI Sr. Engineer)

Sometimes machine diagnostic results can be a source of confusion and varied interpretation. The cited fault severity of mechanical fault diagnoses can include "*SLIGHT*", "*MODERATE*", "*SERIOUS*", or "*EXTREME*", while the repair priorities can range between "*NO REC*" and "*DESIRABLE*" to "*IMPORTANT*" and "*MANDATORY*". What do all those terms mean? In order to answer that question we first need to understand the fixed relationships between fault severity and repair priorities:

FAULT SEVERITY		REPAIR PRIORITY
SLIGHT	=	NO RECOMMENDATION
MODERATE	=	DESIRABLE
SERIOUS	=	IMPORTANT
EXTREME	=	MANDATORY

A "***SLIGHT"*** fault generally means the cited vibration spectral peaks exceed the average baseline values (they are above normal) at those frequencies, but not to the degree warranting any repair action. Thus, a "***NO REC"*** is issued. In fact, the main reasons that "*SLIGHT*" faults are noted are to provide a basis for severity trending over time, and to alert review analysts to abnormal vibration levels that could possibly warrant an upgrade of the fault severity to "*MODERATE*". **Machine repairs should never be based solely upon verified *"SLIGHT"* mechanical fault diagnoses**.

A "***MODERATE***" fault generally means the cited vibration exceeds the average baseline more than would be considered for "*SLIGHT*", and correlates to a "***DESIRABLE***" priority repair recommendation. "*DESIRABLE*" repair priorities encompass a gray area in terms of repair planning, and it's this category that probably causes the most confusion. The basic interpretation is that a machine with a "*MODERATE*" fault and "*DESIRABLE*" repair recommendation has a clearly defined mechanical fault (or at least significantly abnormal vibration), but is not perceived to be in danger of failing. Here are some ideas to consider when presented with a "*DESIRABLE*" repair priority:

If there is a shipyard repair period three to six months away, then order the appropriate parts to have them at hand, and place the repair into the repair package. Meanwhile, pay closer attention to the machine. Are there other faults associated with the machine, such as a leak, low output pressure, or high bearing temperature? In conjunction with a moderate vibration fault such factors could hasten the decision to perform the repair. Depending on the criticality of the machine and the nature of the diagnosis, you may want to increase the testing interval - for example, collect vibration data again in a month rather than waiting three months. DLI has seen some "*MODERATE*" faults indicated at a steady level of severity over a period of a year or two without any apparent degradation. Other times, a "*MODERATE*" fault will degrade quite rapidly. That's why periodic testing and monitoring of severity trends is a necessity for proper repair planning.

A "***SERIOUS***" fault and its accompanying "***IMPORTANT***" repair recommendation generally mean that the component or machine may fail or be seriously damaged within a few months. Parts should be on hand or obtained promptly. Repair should be performed at the next convenient opportunity.

An "***EXTREME***" fault and its accompanying "***MANDATORY***" repair recommendation generally mean that the machine should not be placed in operation until repair has been performed. Component or machine damage has either already occurred or else the present failure or damage of a minor component could soon cause much more costly and catastrophic machine damage.

Whenever more than one diagnosis is cited for a machine major component (such as a motor or a pump), the greater fault severity dictates the repair priority. It's important that shipboard personnel fully understand these terms. Otherwise some might overreact to a ***"SLIGHT"*** or ***"MODERATE"*** diagnosis and immediately overhaul a machine or component based solely on this evidence. Conversely, a valid ***"SERIOUS"*** or ***"EXTREME"*** fault may be ignored and a machine soon fails.

NOTE FROM THE EDITOR: *When vibration is the only indicator of a problem with a piece of machinery, all* ***"IMPORTANT"*** *or* ***"MANDATORY"*** *recommendations should be validated through manual analysis by a DLI Vibration Engineer, prior to taking any repair action.*

Next month's article will look at motor ball bearing wear diagnosis in order to further aid your understanding of the terms discussed herein.